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DETOXICATION OF AUTOCLAVED SOIL
BY A MYCORRHIZAL FUNGUS

by

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ABSTRACT

*Douglas-fir seedlings grown in autoclaved soil were stunted and their roots severely aborted. However, when the same autoclaved soil was inoculated with *Corticium bicolor*, an ectomycorrhizal fungus, seedlings grew normally. Apparently the fungus deactivated toxin(s) formed during autoclaving of the soil. It is suggested that in nature the mycorrhizal fungus may aid tree growth by protecting absorbing roots from soil phytotoxins.*

KEYWORDS: Soil science, roots, seedlings, soil fungi, *Corticium bicolor*, Douglas-fir, *Pseudotsuga menziesii*.

Autoclaving some soils may destroy fungitoxins (Dobbs and Hinson 1953, Lingappa and Lockwood 1961), believed produced by various microorganisms, while autoclaving other soils has been shown to induce formation of substances toxic to bacteria (Peterson 1962). Most soils, however, display phytotoxicity following autoclaving, the degree of toxicity varying with the soil and with the plant (Johnson 1919).

Rovira and Bowen (1966) found that subterranean clover (*Trifolium subterraneum* L.) planted in autoclaved soil suffered stunting and deformation of its root system. Tomato (*Lycopersicon esculentum* Mill.) was also severely stunted. But, when various fungi and bacteria were introduced into the autoclaved soil, normal plant growth resulted. Five of 13 species of fungi tested detoxicated the soil; these included species of *Aspergillus*, *Humicola*, *Mortierella*, *Penicillium*, and *Pythium*. Reported here is the detoxication of an autoclaved soil by a basidiomycetous ectomycorrhizal fungus.

Loam soil from a western Oregon forest tree nursery was screened, thoroughly mixed, and dispensed into twenty 500-milliliter flasks, 250 milliliters per flask. Distilled water was added to each to adjust the soil to approximately field capacity, and the flasks were then autoclaved for 1 hour at 15 pounds of pressure (121° C.). Following sterilization, they were set aside for 1 week before further treatment.

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) seed were surface sterilized with 30 percent hydrogen peroxide and germinated on potato-dextrose agar medium. When radicles were 2 to 3 centimeters long, one seed was planted in each flask. At the time of planting, 10 flasks received 5 milliliters of a nutrient solution suspension of mycelium of *Corticium bicolor* Peck., an ectomycorrhizal fungus of Douglas-fir and other tree species. Five milliliters of nutrient solution only were added to each of the remaining 10 flasks. All flasks were then placed in a growth chamber.

Results after 4 months are illustrated in figure 1, A and B. Seedlings grown in autoclaved soil lacking the fungus (fig. 1, A) were badly stunted and chlorotic with short and weakly developed needles. Terminal needles of some seedlings were almost white and the tops of two seedlings were dead. Root systems were severely aborted and consisted of only a taproot or, at most, a taproot and one to three stubby lateral roots. Short roots and root hairs were absent. Most root tips were dark brown and blunt and some were covered with black, clinkerlike tissue. These symptoms were unlike any produced by common adverse soil conditions, such as lack of nutrients, and can only be ascribed to toxins formed during autoclaving of the soil.

In contrast, seedlings grown in autoclaved soil inoculated with *Corticium bicolor* (fig. 1, B) were large and vigorous, with long, green needles. Their root systems were well developed with many lateral branches. Tips of lateral roots were vigorously white and tapered. The upper third of the root system bore well-formed mycorrhizae to which dense wefts of mycelium were attached.

Lack of toxin damage to any part of the root system, including nonmycorrhizal lateral roots, in the inoculated soil indicates that *Corticium bicolor* detoxicated the soil mass. And, we may speculate that the fungal mantle and closely attached mycelium of the mycorrhiza

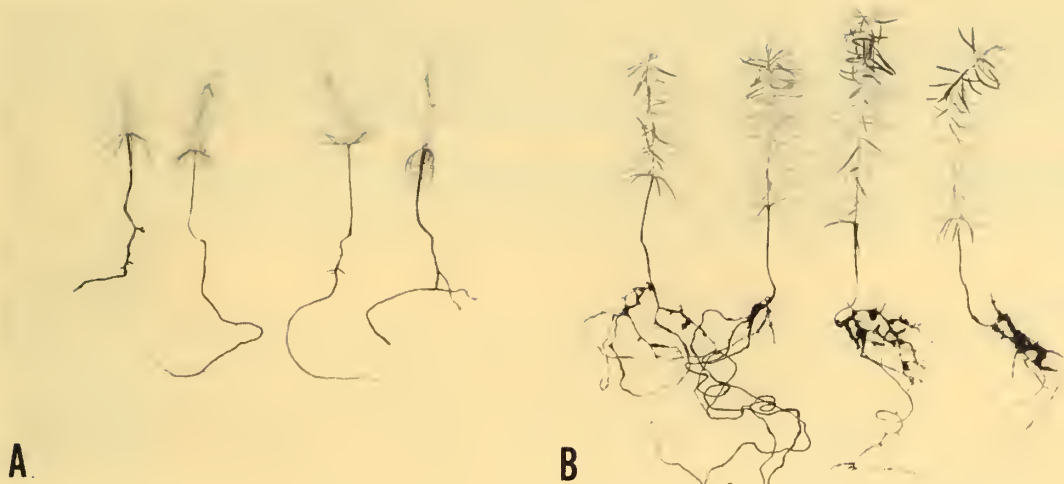


Figure 1.--Douglas-fir seedlings grown for 4 months in autoclaved soil: A, Soil uninoculated; B, soil inoculated with *Corticium bicolor*; seedlings are mycorrhizal.

served as filters blocking entrance of toxic substance(s) into the root. At least, these tissues, together with that part of the fungus permeating the soil, served to deactivate the toxin(s).

Although based on quite unnatural growth conditions, these results may have significance in better understanding the function of the ectomycorrhiza and associated fungal symbiont in growth and survival of the tree in nature. Until recently, the mycorrhiza was thought to benefit the tree wholly by improving the availability and absorption of nutrients. However, a second function of the mycorrhiza is now recognized, that of protecting delicate absorbing root tissue from soil pathogen attack, as outlined by Zak (1964) and clearly demonstrated by experiments of Marx and Davey (1969a, 1969b). The study here reported suggests yet a third function: protection of absorbing roots from soil phytotoxins which, as DeBell (1970) has suggested, may be of importance to tree growth in the forest.

LITERATURE CITED

- DeBell, D. S.
 1970. Phytotoxins--new problems in forestry? J. Forest. 68: 335-337.
- Dobbs, C. G., and W. H. Hinson.
 1953. A widespread fungistasis in soils. Nature 172: 197-199.

- Johnson, J.
1919. The influence of heated soils on seed germination and plant growth. Soil Sci. 7: 1-84.
- Lingappa, B. T., and J. L. Lockwood.
1961. The nature of the widespread soil fungistasis. J. Gen. Microbiol. 26: 473-485.
- Marx, D. H., and C. B. Davey.
1969a. The influence of ectotrophic mycorrhizal fungi on the resistance of pine roots to pathogenic infections. III. Resistance of aseptically formed mycorrhizae to infection by *Phytophthora cinnamomi*. Phytopathology 59: 549-558.
- _____ and C. B. Davey.
1969b. The influence of ectotrophic mycorrhizal fungi on the resistance of pine roots to pathogenic infections. IV. Resistance of naturally occurring mycorrhizae to infections by *Phytophthora cinnamomi*. Phytopathology 59: 559-565.
- Peterson, G. H.
1962. Microbial activity in heat- and electron-sterilized soil seeded with microorganisms. Can. J. Microbiol. 8: 519-524.
- Rovira, A. D., and G. D. Bowen.
1966. The effects of microorganisms upon plant growth. II. Detoxication of heat-sterilized soils by fungi and bacteria. Plant & Soil 25: 129-142.
- Zak, B.
1964. Role of mycorrhizae in root disease. Ann. Rev. Phytopathol. 2: 377-392.